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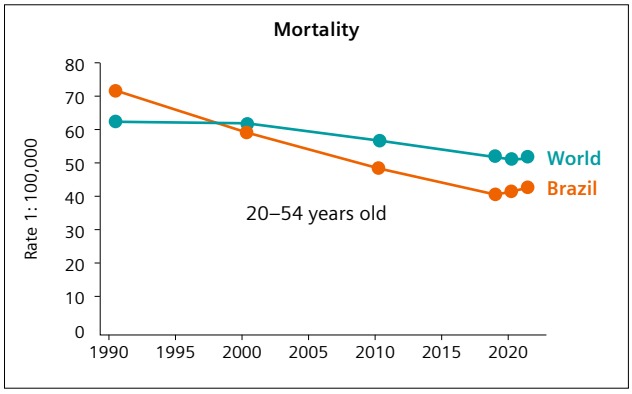
He received his medical degree from São Paulo State University School of Medicine (UNESP), in 1990 and completed his cardiology clinical fellowship in 1993. He earned his Ph.D. in medicine in 2001 at InCor. He was a post-doctoral fellow in cardiovascular MRI at Johns Hopkins Hospital, Baltimore, MD, USA from 1995 to 1999. He is an established researcher in Brazil and has over 350 scientific publications indexed in PubMed, including research papers on myocardial infarctions/microvascular obstruction myocardial sodium-23 CMR studies in animals and humans. He has also pioneered the use of late gadolinium enhancement in four specific non-ischemic cardiomyopathies: Chagas disease, muscular dystrophy, aortic valve disease, and endomyocardial fibrosis. Dr. Rochitte is a founder and the former president (2020–2021) of the Cardiovascular Imaging Department (DIC) of the Brazilian Society of Cardiology (SBC), a founding member and the current President of SCMR and he has been actively participating in SCMR meetings since 1996. He was chair of the Latin American chapter of SCMR, member of the Editorial Board of the Journal of Cardiovascular Magnetic Resonance, member of the Scientific Program Committee, and member of the SCMR Board of Trustees from 2013 to 2017.

Artificial Intelligence in Cardiovascular Magnetic Resonance: From Precision Imaging to Global Accessibility

Cardiovascular magnetic resonance (CMR) is the non-invasive gold standard for assessing cardiac morphology, function, and tissue composition. Yet its clinical dissemination has historically been constrained by technical complexity, long acquisition times, and dependence on expert manual analyses. Segmenting cardiac chambers manually, for instance, may take up to 20 minutes for only two cardiac phases – a limitation that hinders scalability and accessibility, particularly in resource-limited settings.

Beyond these operational challenges, cardiovascular disease (CVD) remains the leading cause of morbidity and mortality worldwide. In Brazil, despite decades of decline, recent data show a subtle reversal of mortality trends among adults aged 20–54 (Fig. 1), signaling a persistent burden of premature cardiovascular events. This reinforces the urgency of making precision diagnostics – such as CMR – accessible, efficient, and globally deployable as tools for early detection and improved disease management. This need for scalable precision imaging aligns with SCMR's mission and strategic plan to democratize CMR and expand its availability across diverse healthcare settings.



1 Trends in cardiovascular disease mortality (in people aged 20–54) in Brazil and worldwide, 1990–2020. While global mortality rates have shown a consistent decline, Brazil experienced a sustained reduction followed by a slight increase in recent years, suggesting a potential reversal of this trend.
Data sources: WHO Mortality Database (2022); Global Burden of Disease Study 1990–2021 (Seattle: IHME, 2022); Saloni Dattani, Veronika Samborska, Hannah Ritchie, and Max Roser, 2023. Courtesy of Dr. Gláucia Moraes, UFRJ.

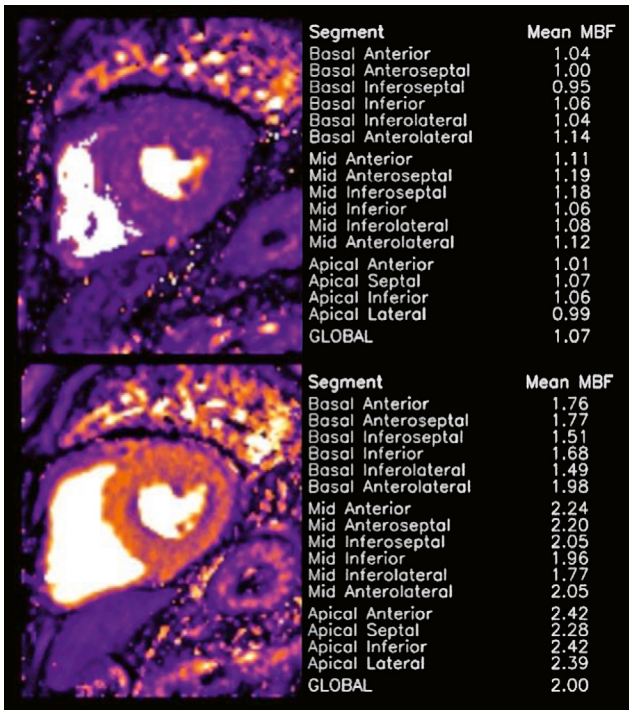
From visualization to quantification: The power of objective imaging

CMR is rapidly evolving from qualitative visualization toward quantitative precision, a shift that redefines its prognostic and diagnostic role. Quantitative perfusion (QP) CMR exemplifies this transformation. By measuring absolute myocardial blood flow (MBF) and myocardial perfusion reserve (MPR), it provides objective, reproducible insights into ischemic burden – overcoming the subjectivity of visual interpretation.

Artificial intelligence (AI)-based corrections for the arterial input function (AIF) now allow accurate single-bolus quantification, eliminating complex dual-bolus protocols and facilitating workflow integration (Fig. 2). Beyond ischemia, tissue characterization techniques – including late gadolinium enhancement (LGE), T1 mapping, and extracellular volume (ECV) quantification – provide deep insight into myocardial remodeling and risk stratification (Fig. 3). Together, these quantitative biomarkers expand CMR's potential as a foundation for precision and predictive cardiology. SCMR consensus documents have been instrumental in harmonizing quantitative acquisition and interpretation, enabling reproducibility across centers internationally.

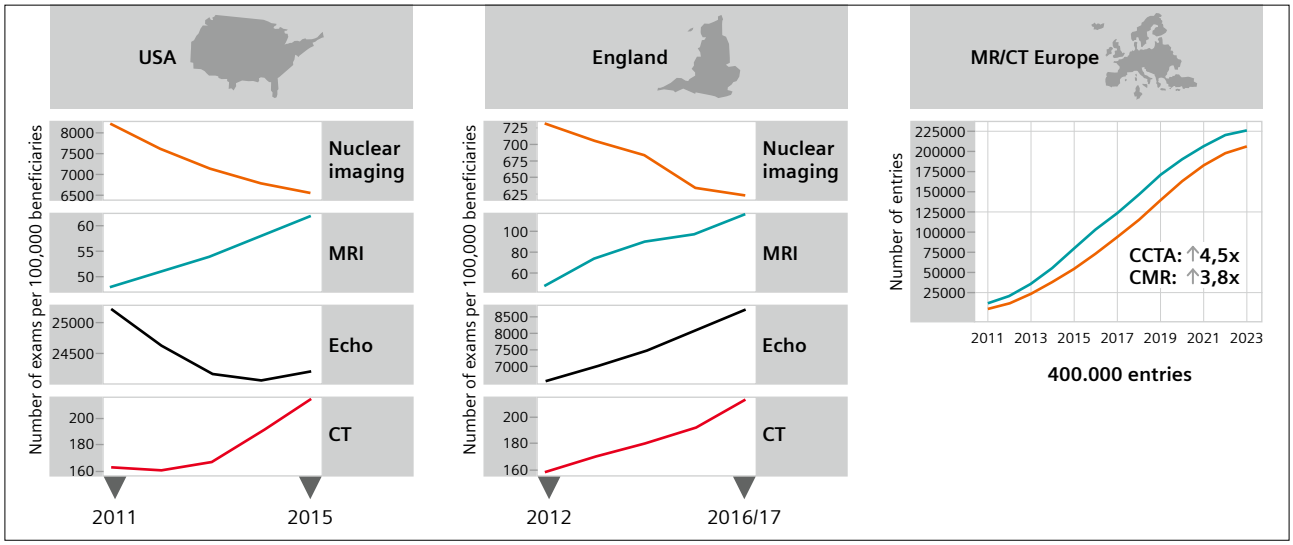
CMR growth worldwide and in Brazil: A shift toward intelligent imaging

Over the past decade, the utilization of CMR has expanded substantially across healthcare systems worldwide. Data from North America and the United Kingdom show a steady rise in clinical adoption, while the MR/CT Registry in Europe reported a 3.8-fold increase between 2011 and 2023, totaling nearly 400,000 studies (Fig. 3). This consistent global expansion highlights the consolidation of CMR as a pivotal tool in cardiovascular diagnosis and management.

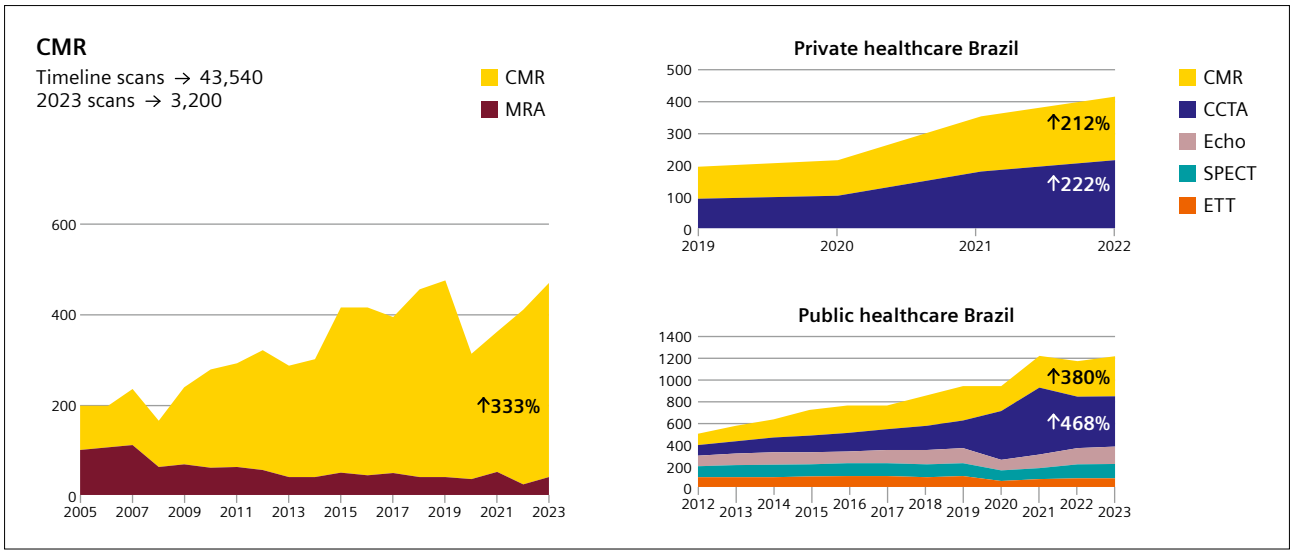


2 Representative quantitative perfusion maps acquired at rest (top) and during pharmacologic stress (bottom), illustrating absolute myocardial blood flow (MBF, mL/min/g) across all left ventricular segments. Segmental MBF values are automatically calculated. Images were acquired using a work-in-progress quantitative perfusion sequence[1] developed at King's College London. It enables high-resolution pixel-wise quantification of myocardial perfusion.

[1] *Work in progress. The application is currently under development and is not for sale in the U.S. and in other countries. Its future availability cannot be ensured.*



3 Increasing global use of CMR across healthcare systems, with a decline in molecular imaging. Data from the MR/CT Registry show a 3.8-fold rise in CMR and 400,000 recorded studies in Europe (2011–2023).



4 Significant growth in CMR utilization across Brazil over the past decade. Data from InCor show a 333% increase in CMR scans, while national trends indicate rises of 380% in the public health system (SUS) and 212% in the supplementary health sector.

In Brazil, the growth has been even more striking. Within the public healthcare system (SUS), CMR utilization has increased by nearly 380% nationwide. In the private health sector, the rise reached 212% across Brazil. Data from the Heart Institute (InCor) at the University of São Paulo show a 333% increase in examinations (Fig. 4). This trajectory reflects both clinical maturity and technological evolution, reinforced by the integration of AI, which is redefining efficiency, accessibility, and precision in modern cardiovascular imaging. Moreover, these trends reflect not only technological progress but also the global outreach and educational programs promoted by SCMR, which have supported CMR adoption in both high- and middle-income regions.

Artificial intelligence: Efficiency, automation, and reproducibility

AI has become an intrinsic component of the CMR workflow, driving efficiency, standardization, and diagnostic reliability. From acquisition to reconstruction, deep learning (DL) models accelerate and simplify processes that were once dependent on highly specialized expertise.

AI-assisted planning and motion correction reduce scan times by up to 30%, while DL-based reconstruction and compressed sensing enable high-resolution cine imaging under free-breathing conditions. In post-processing, convolutional networks achieve near-expert accuracy for automated segmentation of cine (Fig. 5) and LGE datasets, with frameworks such as nnU-Net adapting seamlessly across centers. These advances collectively transform CMR from an expert-dependent modality into an intelligent, scalable, and reproducible diagnostic tool.

New frontiers: Multiparametric and contrast-free imaging

Emerging techniques such as cardiac MR Fingerprinting (cMRF) integrate multiparametric quantification within a single, short acquisition. Simultaneous mapping of T1 and T2 in one breath-hold enhances patient comfort and reproducibility. DL-driven reconstruction reduces computation times to under two minutes while preserving quantitative accuracy.

Virtual native enhancement (VNE) further redefines tissue characterization by generating gadolinium-free "virtual" LGE images from native cine and mapping data. With diagnostic equivalence to conventional LGE and faster acquisition, these methods move CMR toward sustainable, contrast-free imaging that is safer for patients and more environmentally responsible.

Education, equity, and global workforce development

As the leading global society in CMR, SCMR has been pivotal in advancing education and capacity-building. Technology alone cannot democratize access; education remains fundamental. The InCor School of Cardiovascular Magnetic Resonance and Computed Tomography exemplifies this integration of innovation and capacity-building. To date, 250 residents and fellows have been trained in advanced CMR techniques, forming a distributed network of specialists now active in Brazil, Latin America, the United States, Europe, and Oceania (Fig. 6).

This global educational model, grounded in inclusion, diversity, and equity (IDE), ensures that technological advancement translates into equitable clinical benefit. The InCor experience demonstrates how innovation and human development must progress hand in hand to

achieve true scalability and sustainability in precision imaging.

Responsible innovation: The path forward

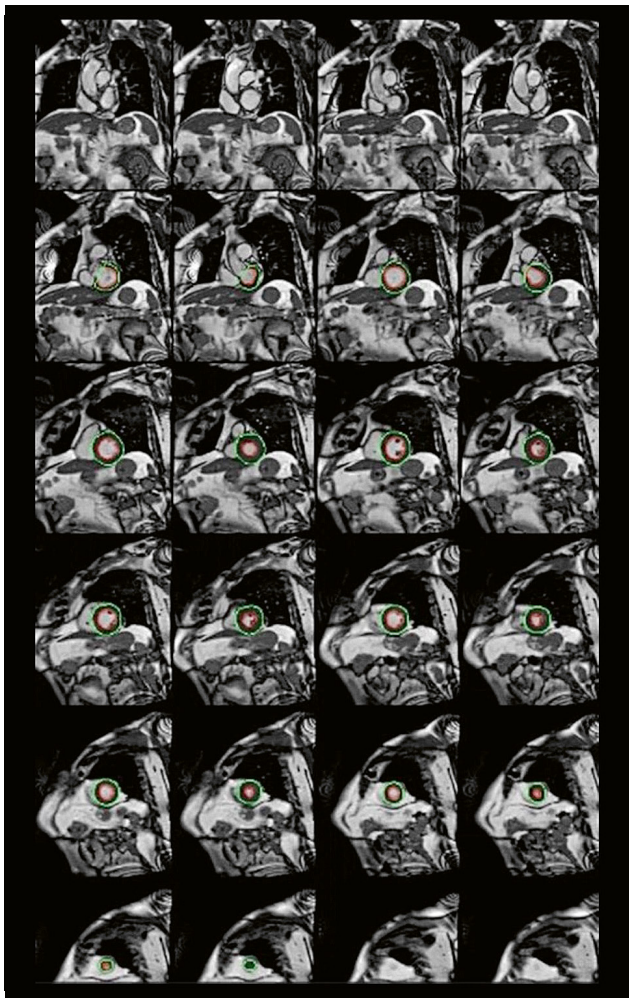
AI-enabled CMR is no longer aspirational; it is a living reality transforming how we acquire, reconstruct, and interpret cardiac data. Yet progress demands responsibility. Ensuring data diversity, compliance with FAIR (findable, accessible, interoperable, reusable) principles and with the Checklist for Artificial Intelligence in Medical Imaging (CLAIM), and transparent model validation are essential for equitable adoption.

Ultimately, the success of AI in CMR will not be measured by speed or automation alone, but also by its impact on patient outcomes and access. When technology, education, and ethics converge, precision medicine becomes a collective achievement – one that bridges innovation with inclusion and transforms cardiovascular health across all regions.

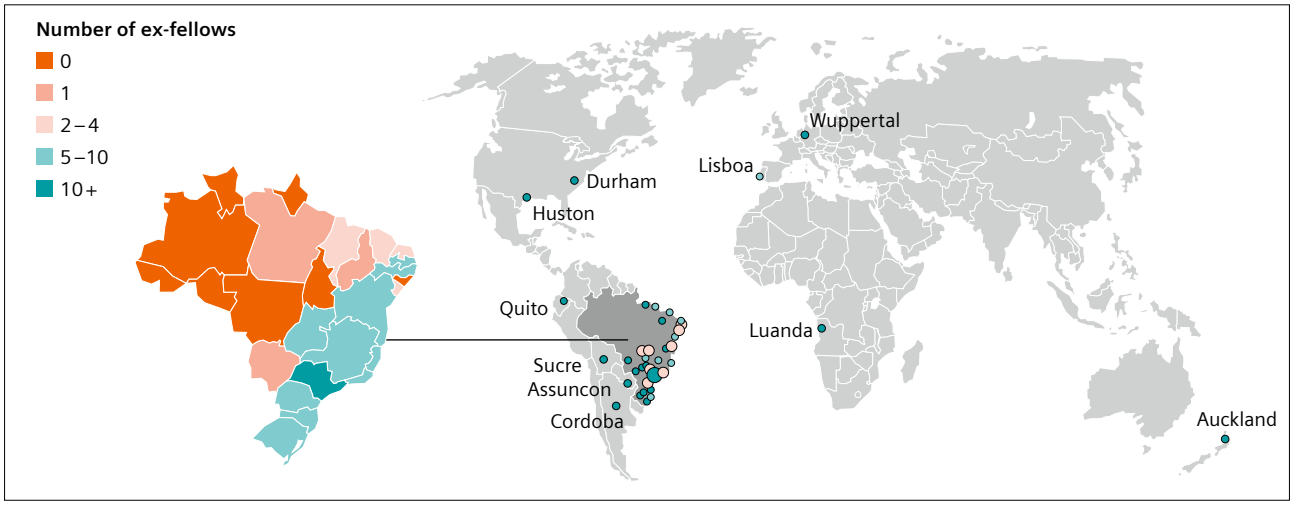
Conclusion: A transformative opportunity requiring responsible stewardship

AI-enabled CMR is no longer a vision of the future; it is an evolving reality that is redefining how we acquire, process, and interpret cardiac data. From accelerating acquisitions and reconstructing images in near real-time to enabling contrast-free tissue characterization and fully automated quantification, AI is transforming CMR into a faster, more accessible, and more predictive tool for patient care. Yet this transformation demands more than algorithms; it requires stewardship, collaboration, and ethical responsibility.

The democratization of high-precision cardiovascular imaging depends on ensuring that innovation is coupled with inclusivity. Initiatives such as those led by InCor



5 Automated segmentation and quantification of left ventricular function using fully convolutional networks (FCNs), demonstrating accurate contouring and volumetric analysis comparable to expert manual assessment.



6 Global distribution of InCor-trained fellows in cardiovascular imaging, showing their presence across Brazil and internationally.

exemplify how technological advancement and education can move in parallel – empowering clinicians, expanding regional expertise, and building sustainable models of care that transcend geographic and socioeconomic barriers. Through its guidelines, registry efforts, and global training initiatives, SCMR continues to play a central role in guiding responsible innovation and equitable dissemination of CMR.

As CMR enters the era of intelligent automation, its greatest promise lies not merely in speed or efficiency, but also in its capacity to humanize precision medicine – to deliver data-driven insights that improve outcomes for all, not just for those with privileged access. Achieving this future will depend on global collaboration among clinicians, scientists, and policymakers who share a common goal: transforming cardiovascular imaging into a truly equitable, data-driven discipline that serves the world's diverse populations with excellence and compassion.

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